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MEETING PAPER

THREE-DIMENSIONAL SOLUTION MINED CAVERN VISUALIZATION

by

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1993 Fall Meeting
October 24-28, 1993
Lafayette, Louisiana

ABSTRACT

A technique has been developed which allows the construction of three-dimensional images of solution mined storage caverns. Using data files which are translated from sonic survey data provided by Sonar-wire, Inc., the construction of full three-dimensional representations of the caverns is possible. Once the cavern geometry data are translated into a Computer Aided Drafting (CAD) program, viewing from any desired perspective is possible. When lighting and material properties are added, a photo realistic three-dimensional rendering may be created of any desired perspective. If an overall view of the cavern is desired, an animation where the cavern is slowly rotated in the field of view may be output onto standard VHS video tape. These animations are valuable tools in the examination of caverns for the location and evaluation of anomalous regions, or to get a feel for the overall geometry of the cavern. With this technique, regions of preferential or retarded leaching are clearly visible, as well as locations of potential salt falls or slabbing. This technique is applicable to any cavern that can be sonar logged, and is a valuable tool for the presentation and evaluation of underground facilities.

This work was performed at Sandia National Laboratories and supported by the U.S. Department of Energy under Contract DE ACO-76DP00789.

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Introduction

Sonar imaging of solution mined caverns is a valuable tool for the management and assessment of the solution mining process as well as for the periodic inspection of caverns after they have been placed in service. To date, the display of the sonar data has been limited to two-dimensional cross sections and siiple isometric line drawings of the caverns. From these images, it may sometimes be difficult to construct a true representation of how the cavern appears in three-dimensions.

A technique for the creation and visualiition of fully three-dimensional cavern sonar image models is presented in this paper. The steps required to prepare the model and possible directions for future development are discussed.

Creation of the three-dimensional model

Building the three-dimensional representation of a cavern begins with converting the sonar survey file to a format that can be manipulated in a three-dimensional Computer Aided Drafting (CAD) software package. The sonar data for the examples presented in this paper, as well as the conversion routines used, were provided by Gary McCool of Sonar-wire, Inc. The conversion routine yields a three-dimensional Data exchange Format (DXF)[1] file which is compatible with many of the popular drafting and rendering packages which are commercially available. The cavern is described by 3D faces that enclose the cavern which are formed from the sonar data points.

From the DXF file, the image may be imported into a CAD package for wire frame display and model manipulation. For this work, the AutoCAD[2] drafting package was used. Following image cleaning and manipulation in AutoCAD, it is translated into a photo realistic rendering package for the addition of lighting, material properties, and camera positioning. For this work, the Autodesk 3D Studio (Release 2; 1993; Autodesk, Inc.; Sausalito, CA) modeling and animation application program was used.

[1] DXF and 3D Studio are trademarks of Autodesk, Inc.
[2] AutoCAD is a registered trademark of Autodesk, Inc.

Shown in Figures 1 through 3 are sample renderings which have been completed. These three figures show how diierent types of shading and lighting can produce different desired effects in the final rendering. Figure 4 is an example of how this technique may be used to examine particular regions of interest within a cavern - significant preferential leaching is displayed. As is shown, the three-dimensional presentation of this region allows complex surfaces and features to be easily understood and examined.

As a final step, many images may be displayed on the computer sequentially, with the camera point being slightly moved in each successive frame. This gives the impression that the cavern is being rotated in the field of view, and allows even greater detail to be easily seen. This computer animation may then be transferred to a video tape and played on a standard VHS VCR for presentation.

All of the images that are shown were produced on an IBM compatible 80486 computer running at 33 MHz. Single images may be rendered in a few minutes, while the animation sequences can easily take several hours to produce.

Conclusions

The visualization technique which has been developed and discussed in this work is a dramatic and important step in the presentation and examination of sonar survey data. With this tool, data which may appear ambiguous when displayed in cross section or as simple three-dimensional line drawings, become easily visible and clear. With further interest and development, higher resolution images and animations with greater detail are possible.

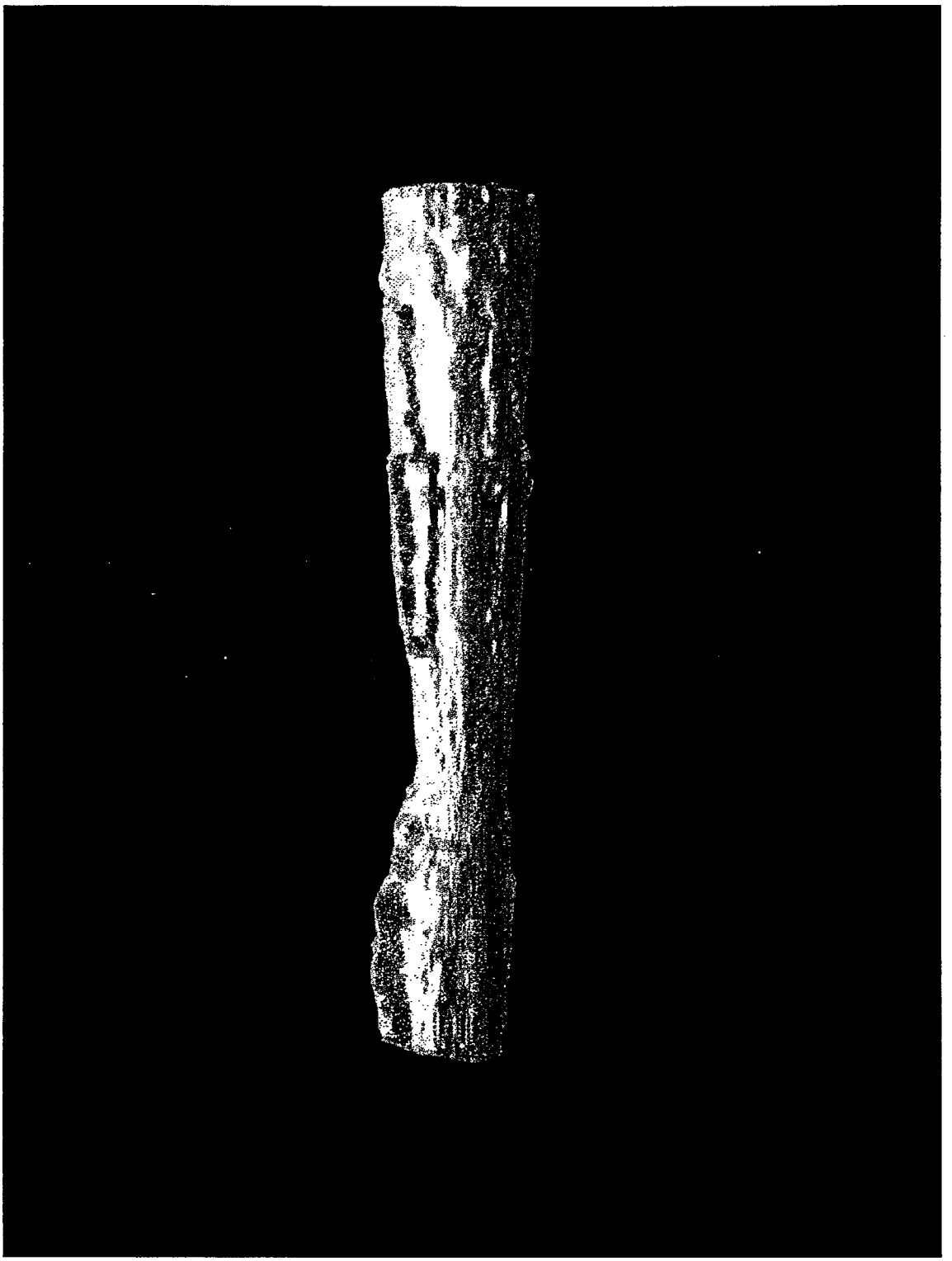

Figure 1: Bayou Choctaw Cavern 10 1

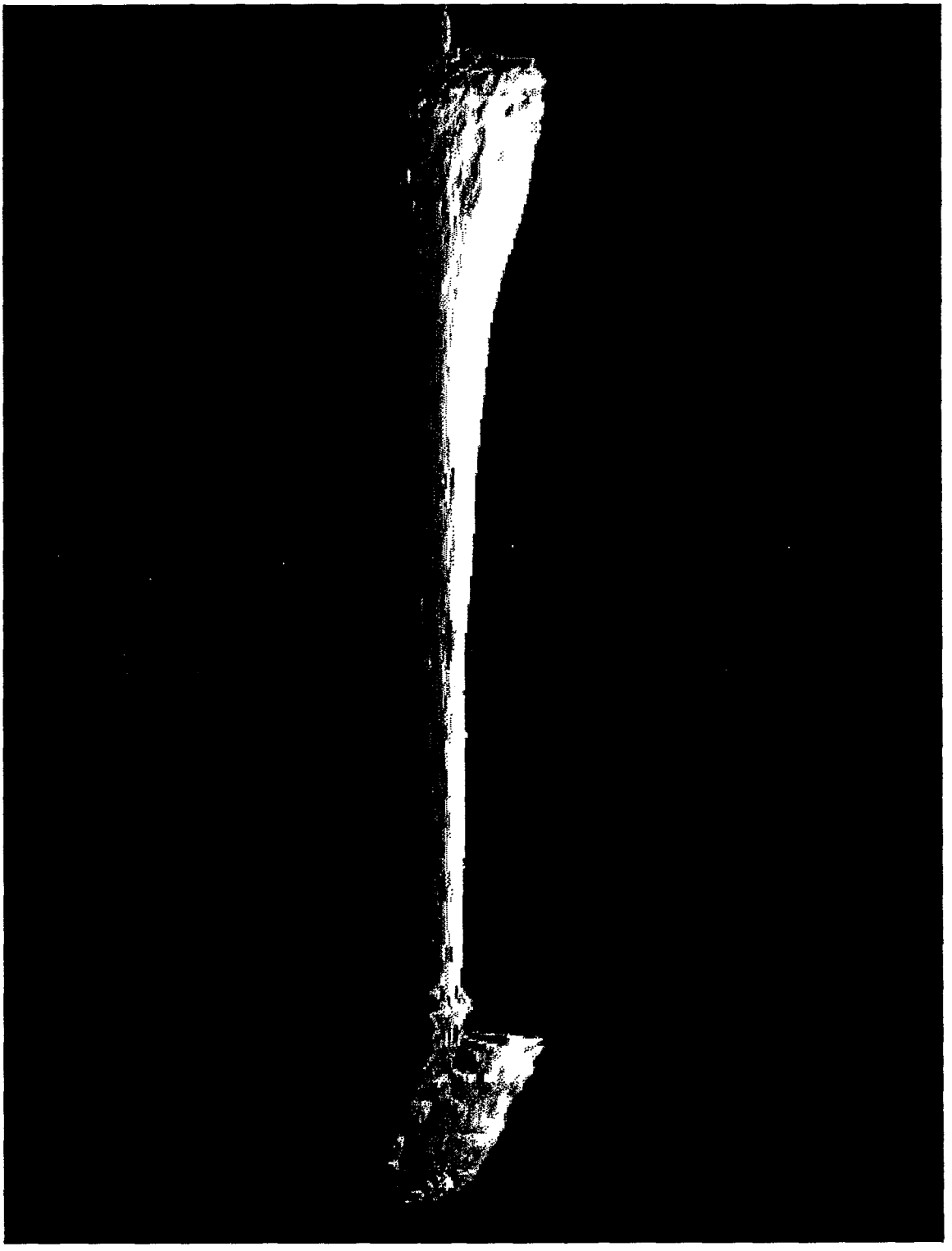

Figure 2: Moss Bluff Gas Storage Systems Cavern 1

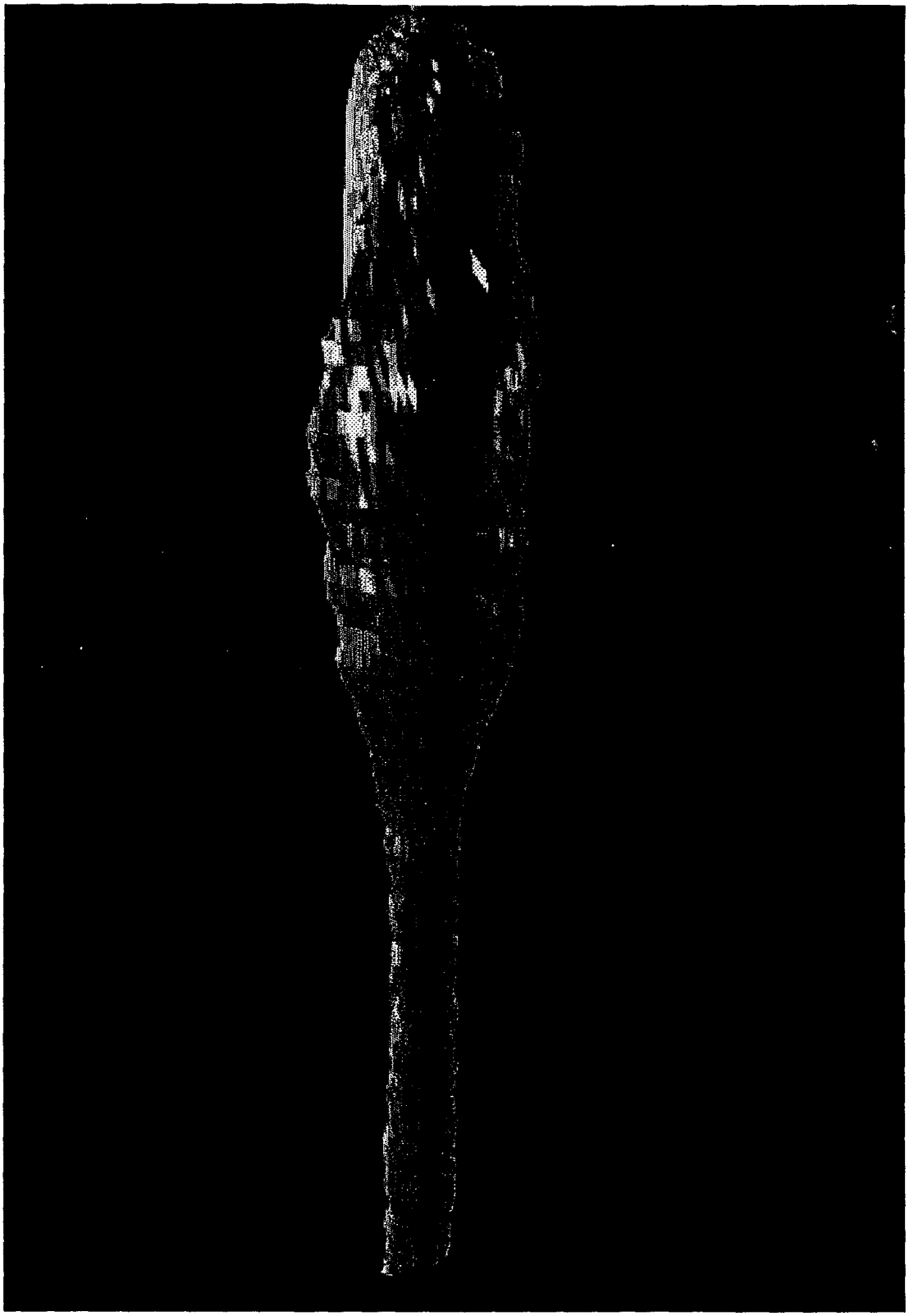

Figure 3: Moss Bluff Gas Storage Systems Cavern 2

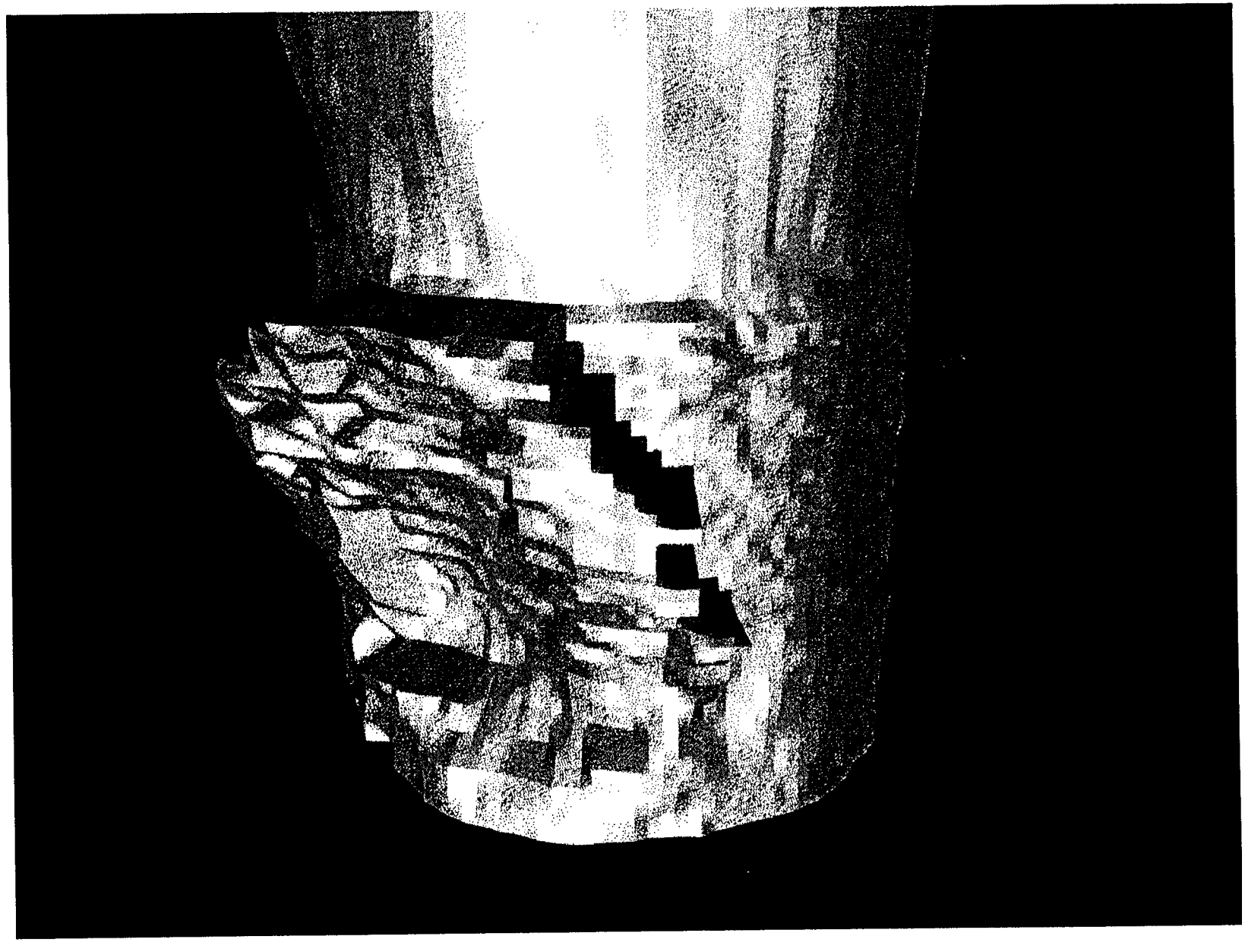

Figure 4: Regions of Special Interest